

## CLAIMS

What is claimed is:

- 1 1. A method for constructing an overlay multicast tree to deliver data from a source  
2 to an identified group of nodes, the method comprising:  
3 identifying a plurality of nodes;  
4 mapping the nodes into multidimensional space;  
5 constructing a geometric region comprising a size that is the minimum size  
6 necessary to contain the source and all the nodes;  
7 creating a tree beginning at the source and including all of the nodes within the  
8 geometric region.
- 1 2. The method of claim 1, wherein the step of constructing a geometric region  
2 comprises constructing a circular region.
- 1 3. The method of claim 1, wherein the step of mapping the nodes into  
2 multidimensional space comprises mapping the nodes into multidimensional  
3 Euclidean space.
- 1 4. The method of claim 1, further comprising creating a grid within the geometric  
2 region.
- 1 5. The method of claim 4, wherein the step of creating a grid comprises creating a  
2 grid comprising a plurality of cells such that all of the cells comprise a  
3 substantially equivalent amount of area.
- 1 6. The method of claim 5, wherein the step of creating a tree comprises selecting a  
2 representative node for each cell containing at least one node and connecting first  
3 to the representative nodes.

1 7. The method of claim 6, wherein the representative node is selected to be the node  
2 within each cell that is closest to the source.

1 8. The method of claim 7, further comprising, for cells containing two nodes one of  
2 which is the representative node, connecting the representative node to a second  
3 node in the same cell and using the second node to connect to the representative  
4 nodes in at least two cells in an outer ring.

1 9. The method of claim 7, further comprising, for cells containing three or more  
2 nodes one of which is the representative node, selecting a second node in the  
3 same cell to connect to additional nodes in the cell and selecting a third node in  
4 the cell to connect to the representative nodes in at least two cells in an outer ring.

1 10. The method of claim 6, further comprising connecting additional nodes within  
2 each cell.

1 11. The method of claim 10, wherein the step of connecting to additional points  
2 within each cell comprises using a constant factor approximation algorithm.

1 12. The method of claim 4, wherein the step of constructing a geometric region  
2 comprises constructing a circular region and the step of constructing a grid  
3 comprises constructing a polar grid comprising a plurality of cells having  
4 substantially equal areas.

1 13. The method of claim 12, wherein the step of constructing a polar grid comprises  
2 dividing the circle into a plurality of rings by constructing a sequence of circles of  
3 decreasing radius concentric with the source such that each subsequent circle  
4 divides substantially in half an area bounded by a next largest circle, and placing a

5           number of the cells into each one of the plurality of rings such that the number of  
6           cells per ring doubles with each ring moving radially outward from the source.

1    14.    The method of claim 12, wherein the step of dividing the circle into a plurality of  
2           rings comprises dividing the circle into the maximum number of rings such that  
3           there is at least one node in each cell except for cells disposed in an outermost  
4           ring.

1    15.    The method of claim 1, wherein the step of creating a tree comprises using an out-  
2           degree less than two for each node in the tree.

1    16.    A computer readable medium containing a computer executable code that when  
2           read by a computer causes the computer to perform a method for constructing an  
3           overlay multicast tree to deliver data from a source to an identified group of  
4           nodes, the method comprising:  
5           identifying a plurality of nodes;  
6           mapping the nodes into multidimensional space;  
7           constructing a geometric region comprising a size that is the minimum size  
8           necessary to contain the source and all the nodes;  
9           creating a tree beginning at the source and including all of the nodes within the  
10          geometric region.

1    17.    The computer readable medium of claim 16, wherein the step of constructing a  
2           geometric region comprises constructing a circular region.

1    18.    The computer readable medium of claim 16, wherein the step of mapping the  
2           nodes into multidimensional space comprises mapping the nodes into  
3           multidimensional Euclidean space.

- 1 19. The computer readable medium of claim 16, further comprising creating a grid  
2 within the geometric region.
- 1 20. The computer readable medium of claim 19, wherein the step of creating a grid  
2 comprises creating a grid comprising a plurality of cells such that all of the cells  
3 comprise a substantially equivalent amount of area.
- 1 21. The computer readable medium of claim 20, wherein the step of creating a tree  
2 comprises selecting a representative node for each cell containing at least one  
3 node and connecting first to the representative nodes.
- 1 22. The computer readable medium of claim 21, wherein the representative node is  
2 selected to be the node within each cell that is closest to the source.
- 1 23. The computer readable medium of claim 22, further comprising, for cells  
2 containing two nodes one of which is the representative node, connecting the  
3 representative node to a second node in the same cell and using the second node  
4 to connect to the representative nodes in at least two cells in an outer ring.
- 1 24. The computer readable medium of claim 22, further comprising, for cells  
2 containing three or more nodes one of which is the representative node, selecting  
3 a second node in the same cell to connect to additional nodes in the cell and  
4 selecting a third node in the cell to connect to the representative nodes in at least  
5 two cells in an outer ring.
- 1 25. The computer readable medium of claim 21, further comprising connecting  
2 additional nodes within each cell.

- 1 26. The computer readable medium of claim 25, wherein the step of connecting to  
2 additional points within each cell comprises using a constant factor approximation  
3 algorithm.
- 1 27. The computer readable medium of claim 19, wherein the step of constructing a  
2 geometric region comprises constructing a circular region and the step of  
3 constructing a grid comprises constructing a polar grid comprising a plurality of  
4 cells having substantially equal areas.
- 1 28. The computer readable medium of claim 27, wherein the step of constructing a  
2 polar grid comprises dividing the circle into a plurality of rings by constructing a  
3 sequence of circles of decreasing radius concentric with the source such that each  
4 subsequent circle divides substantially in half an area bounded by a next largest  
5 circle, and placing a number of the cells into each one of the plurality of rings  
6 such that the number of cells per ring doubles with each ring moving radially  
7 outward from the source.
- 1 29. The computer readable medium of claim 27, wherein the step of dividing the  
2 circle into a plurality of rings comprises dividing the circle into the maximum  
3 number of rings such that there is at least one node in each cell except for cells  
4 disposed in an outermost ring.
- 1 30. The computer readable medium of claim 16, wherein the step of creating a tree  
2 comprises using an out-degree less than two for each node in the tree.
- 1 31. An overlay network comprising:  
2 a source having an out-degree of no more than ten; and  
3 a plurality of nodes in communication with the source, each node comprising an  
4 out-degree of no more than ten.

- 1 32. The network of claim 31, wherein the source and the nodes each have an out-  
2 degree of no more than two.
- 1 33. The network of claim 31, wherein the source and nodes are mapped into a  
2 geometric region in multidimensional space, the geometric region having a  
3 minimum size necessary to contain the source and the nodes.
- 1 34. The network of claim 33, wherein the multidimensional space is multidimensional  
2 Euclidean space.
- 1 35. The network of claim 33, wherein the geometric region comprises a circle having  
2 a radius equal to a distance between the source and a node located a farthest  
3 distance from the source.
- 1 36. The network of claim 33, wherein the geometric region comprises a sphere having  
2 a radius equal to a distance between the source and a node located a farthest  
3 distance from the source.